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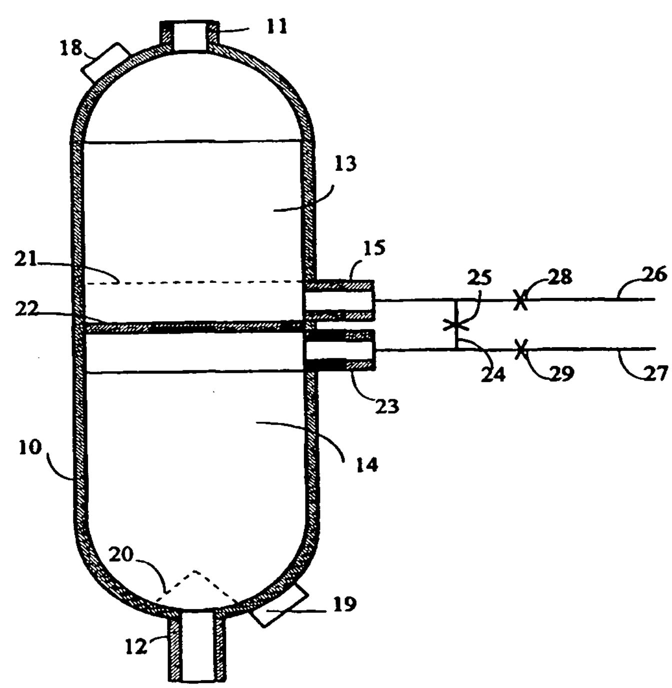
(54) Title: PROCESS FOR TREATING A FLUID USING TWO BEDS CONTAINING DISSIMILAR PARTICULATE MATERIAL

(57) Abstract

A fluid is treated, e.g. purified, by passing the fluid successively through a first bed (13) of a first particulate material and a second bed (14) of a second, dissimilar, particulate material. The beds are disposed within a single vessel provided with primary ports (16, 12) for the inlet and outlet of the fluid stream and with a secondary port (15, 23) connecting with a region between said first and second beds. Periodically a dissimilar fluid stream, or the fluid stream at a different temperature, is passed through one of said beds by passage from one of the primary ports to the secondary port or vice versa, e.g. to effect regeneration of that one bed.



PROCESS FOR TREATING A FLUID USING TWO BEDS CONTAINING DISSIMILAR PARTICULATE MATERIAL

This invention relates to a fluid processing and in particular to a process wherein a process fluid is contacted successively with beds of dissimilar particulate material, e.g. catalysts or sorbents.

In the processing of fluid streams it is often desirable to subject the process fluid stream to a plurality of processing steps in which the stream is successively contacted with beds particulate materials. For example it may be desirable to contact the process fluid with a particulate sorbent material, such as a molecular sieve, to adsorb impurity components from the process fluid stream, and then to contact the so-treated process fluid stream with a different particulate material which performs a similar or different function.

In many cases periodically it is desirable to treat one of the beds with a different fluid, or with the fluid under different conditions of e.g. temperature. Contact of the material in the other bed with the dissimilar fluid and/or under the dissimilar conditions may be undesirable. For example, after adsorbing impurities from a process fluid stream using a bed of a molecular sieve material, it may be desirable to regenerate the molecular sieve by subjecting the latter to an increased temperature and/or by passing a different fluid stream through the molecular sieve. Subjecting another bed to such increased temperature and/or contact with the different fluid might have an adverse effect upon the material of that other bed. In order to avoid such problems the beds are often disposed in separate vessels.

Particularly when operating on a large scale at high pressures, particularly at above about 50 bar abs., the cost of individual vessels is very high. In the present invention the dissimilar beds are located within the same vessel and so capital cost savings may be achieved.

Accordingly the present invention provides a process for the treatment of a process fluid comprising passing the process fluid successively through a first bed of a first particulate material and a second bed of a second, dissimilar, particulate material, wherein said beds are disposed within a single vessel provided with primary ports for the inlet and outlet of the fluid stream and with a secondary port connecting with a region between said first and second beds, and periodically passing a dissimilar fluid stream, or a fluid stream at a different temperature, through one of said beds by passage from one of said primary ports to said secondary port or vice versa.

The vessel thus has a primary port associated with, and forming an inlet to, the first bed, a secondary port communicating with a region between the beds, and a second primary port associated with, and forming an outlet from, the second bed. During normal operation of the process, the process fluid enters the vessel through the primary port associated with the first bed, passes through the beds and then leaves the vessel via the primary port associated with the second bed. During the periodic treatment, the flow of fluid through one of the primary ports is stopped, e.g. by means of a suitable isolating valve, and the fluid employed in the periodic treatment enters the vessel through the primary port associated with the bed requiring treatment and leaves the vessel via the secondary port. Alternatively the fluid employed in the periodic treatment enters the vessel

In Figures 1 and 2 there is shown a preferred form of vessel for containing two beds. The vessel has an outer shell 10 and is provided with two primary ports, an inlet port 11 at the upper end and an outlet port 12 at the lower end. The first bed 13 is disposed in the upper part of the vessel and the second bed 14 is disposed in the lower part of the vessel. Disposed across the interior of the shell 10 and passing out through the shell is a hollow header 15 forming a secondary port. Extending laterally from header 15 are a plurality of pipes 16. These pipes are closed at their outer ends but at their inner ends communicate with the interior of header 15. Pipes 16 have a plurality of perforations (not shown in Figures 1 or 2) therethrough. Surrounding each lateral pipe 16 is a mesh cage 17.

In use, the vessel is charged with the particulate materials through a manhole 18 at the upper end of the shell 10. The particulate material below header 15 and lateral pipes 16 forms the second bed 14 while the particulate material above header 15 and pipes 16 forms the first bed 13. The mesh cages 17 serve to prevent the particles from blocking the perforations in pipes 16. A manhole 19 is provided to permit the particulate materials forming the beds to be discharged. A perforate grid 20 is provided adjacent the outlet port 12 to prevent the particulate material from entering the outlet port 12.

If desired, a particle restraining grid can be disposed above header 15 to maintain the first and second beds separate. In that case a free space may be provided below the particle restraining grid and the particles in the lower, second, bed 14. In this case the header 15 and its associated lateral pipes 16 and cages 17 may be replaced simply be a port through the wall of vessel 10.

In another embodiment, as shown in Figure 3, a particle restraining grid 21 is provided to define the lower end of the upper bed 13. A partition plate 22 is provided below this grid 21 and the secondary port 15 is simply a port extending through the shell 10. A further secondary port 23 is provided through the shell 10 communicating with the space below partiction plate 22. Secondary ports 15 and 23 are connected external to the shell 10 by a conduit 24 provided with an isolating valve 25. Further conduits 26, 27, provided with isolating valves 28, 29, communicate with secondary ports 15, 23 respectively.

In normal operation, isolating valves 28 and 29 are closed and valve 25 is open so that the process fluid passes from inlet 11, through bed 13 out of the shell 10 through secondary port 15, through connecting conduit 24, back into the vessel through secondary port 23, and thence through bed 14 to outlet port 12. When it is desired to give the relevant bed its periodic treatment, the isolating valve 25 is closed: if bed 13 is to be treated, the appropriate treatment fluid is fed via conduit 26 into secondary port 15, through bed 13, and out through primary port 11. Alternatively the treatment fluid is fed via primary port 11, through the bed 13, and then out of the shell via secondary port 15. Bed 14 can be treated analogously: thus treatment fluid may be fed via conduit 27 into secondary port 23, through bed 14, and out through primary port 12. Alternatively

a bed of a molecular sieve employed to effect drying and the second bed is a sorbent for sulphur compounds: a dry process fluid having a sulphur content meeting a desired specification can thus be achieved.

In the embodiments of Figures 1 to 4, the beds are shown as axial flow beds. However it will be appreciated that in some cases, particularly where it is desired that the fluid only undergoes a small pressure drop during passage through the bed, it may be desirable to employ a radial flow configuration for one or both beds. In particular, it may be desirable to employ a radial flow configuration for the first bed in the aforementioned instance where only part of the process fluid passes through the second bed.

The invention is of particular utility in the following applications:

a) Drying a hydrocarbon fluid, such as natural gas, particularly in the dense phase, typically at a pressure above 100 bar abs., by passage through a bed of a particulate molecular sieve, and then passing the dried fluid through a bed of a particulate absorbent for mercury, especially copper sulphide. The periodic treatment involves regeneration of the molecular sieve by passing therethrough a stream of a heated fluid, particularly a hydrocarbon.

b) Purification of a fluid stream, such as a hydrocarbon, containing contaminants such as waxes by passage through a bed of a particulate high surface area adsorbent such as activated alumina or activated carbon, and then removing other contaminants such as sulphur compounds by passage through a second bed of a particulate composition comprising zinc and/or copper oxides, carbonates or basic carbonates. Regeneration of the high surface area adsorbent bed to remove the deposited waxes is effected periodically with a stream of a gas at an elevated temperature. If the waxes were not removed, the pores of the material of the second bed would tend to become blocked by the waxes rendering the second bed ineffective.

c) Removal of traces of sulphur compounds such as carbonyl sulphide and/or hydrogen sulphide from a gas stream such as propylene by passage through a bed of a particulate material effective to remove such sulphur compounds, for example copper oxide or basic copper carbonate, possibly containing alumina where the gas contains carbonyl sulphide. The copper compound absorbs the hydrogen sulphide producing water as a byproduct

$$CuO + H_2S \text{ -----> } CuS + H_2O$$

Some of the water may effect hydrolysis of carbonyl sulphide

$$COS + H_2O \text{ -----> } CO_2 + H_2S$$

The residual water and/or carbon dioxide may be removed by passage through a second bed of a suitable particulate absorbent, e.g. a molecular sieve, which requires periodic regeneration by means of e.g. a gas stream at an elevated temperature.

d) Hydrodesulphurising a feedstock such as a hydrocarbon, e.g. natural gas, by passage of the feedstock in admixture with hydrogen, at an elevated temperature, through a bed of a particulate hydrodesulphurisation catalyst, such as a sulphided cobalt-, or nickel-, molybdate

Claims

1. A process for the treatment of a process fluid comprising passing the process fluid successively through a first bed of a first particulate material and a second bed of a second, dissimilar, particulate material, wherein said beds are disposed within a single vessel provided with primary ports for the inlet and outlet of the fluid stream and with a secondary port connecting with a region between said first and second beds, and periodically passing a dissimilar fluid stream, or a fluid stream at a different temperature, through one of said beds by passage from one of said primary ports to said secondary port or vice versa.

2. A process according to claim 1 wherein all of the process fluid is passed through one bed, part is discharged through the secondary port and the remainder is passed through the second bed, and then the process fluid that has passed through the second bed is combined with the process fluid that has been discharged through the secondary port.

3. A process according to claim 1 or claim 2 wherein the beds are separated from one another by a partition and a first secondary port is disposed at the outlet side of the first bed and a second secondary port is disposed at the inlet side of the second bed and said first and second secondary ports are connected outside said vessel.

4. A process according to any one of claims 1 to 3 wherein one bed is a bed of a molecular sieve and the other bed is a bed of a particulate absorbent and the periodic treatment comprises regeneration of the molecular sieve by passing a heated fluid stream through the molecular sieve bed.

5. A process according to any one of claims 1 to 3 wherein the periodic treatment comprises a regeneration step wherein a regeneration fluid through at least one of the beds and for at least part of the regeneration step, the regeneration fluid is passed through only one of the beds.

6. A process according to claim 5, wherein the regeneration step comprises a) passing a regeneration fluid at a first temperature through both beds and then b) passing the regeneration fluid at a second, higher, temperature through only one of the beds.

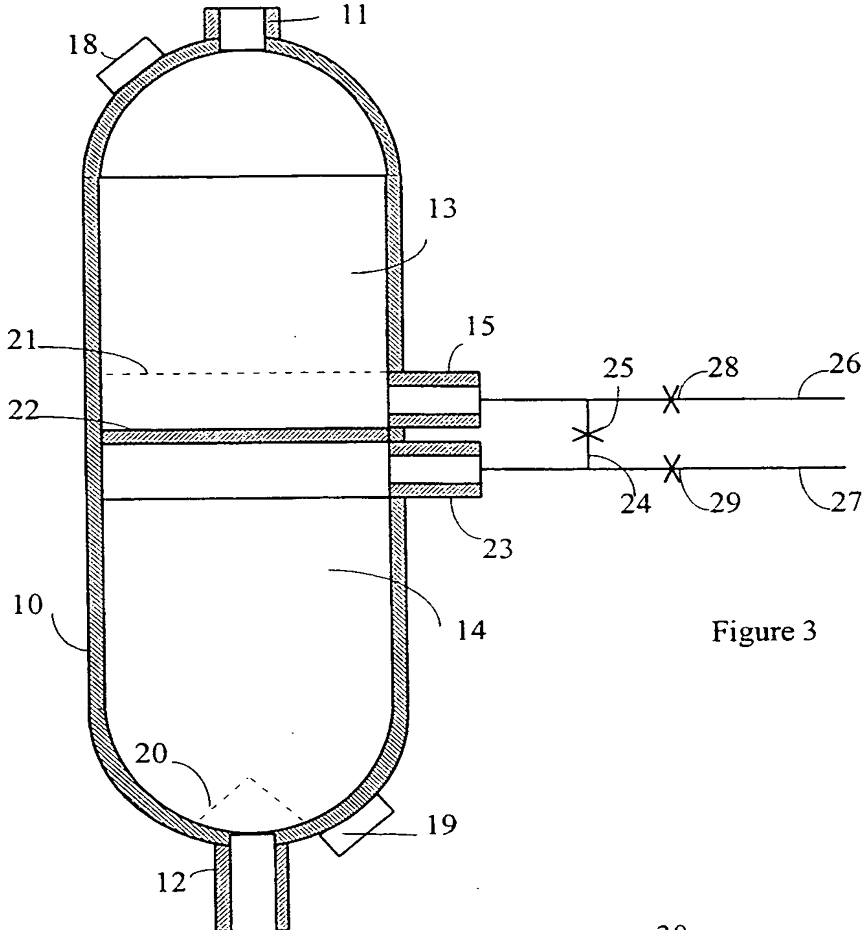


Figure 3

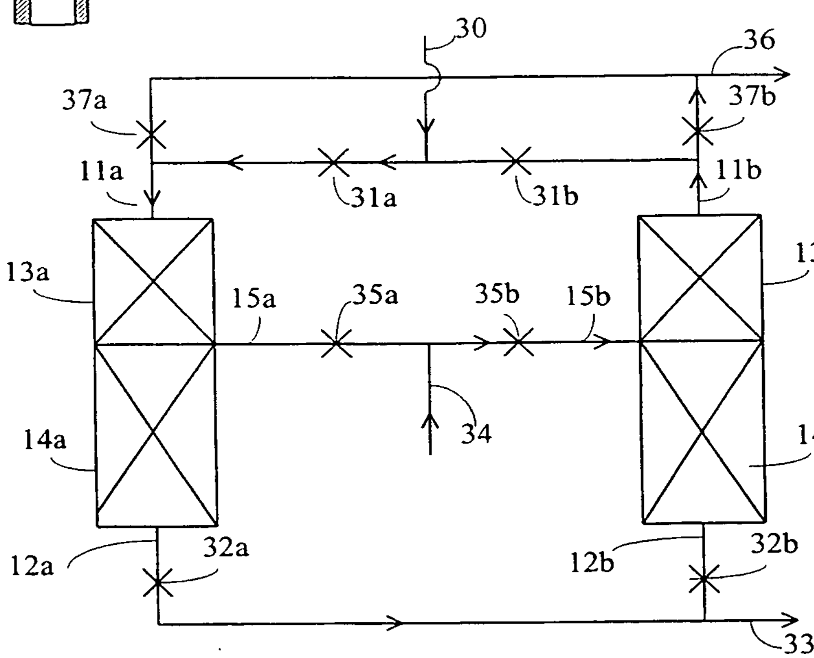


Figure 4

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 99/01343

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